

## YDI Wireless REPLY COMMENTS

In the matter of )  
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Modification of Parts 2 and 15 of the )  
Commission's Rules for unlicensed devices ) ET Docket No. 03-201  
and equipment approval. )

### INTRODUCTION

**YDI Wireless, Inc.** is pleased that the FCC is interested in support the growth of the license-free spectrum for use in high-speed wireless data applications and, most notably, for Internet access. YDI is a leading world supplier of high-speed license-free wireless data communication systems and offers some of the most technically advanced wireless data communication equipment available. YDI has built its reputation on 2.4 GHz and 5 GHz extended range solutions. We now also have license-free systems that operate on 24 and 60 GHz as well. YDI currently manufactures and supplies equipment to thousands of Wireless ISPs and businesses worldwide. We were one of the first vendors to offer 2.4 GHz Direct Sequence Spread Spectrum (DSSS) systems and published the following White Paper several years ago:

<http://www.ydi.com/deployinfo/wp-using-24ghz.php>

We are pleased to provide the following comments and suggestions to the Commission in the matter of this NPRM. Comments are offered in reference to the paragraph found in the NPRM. For the reader's convenience, we include the paragraph from the NPRM itself.

12. *Sectorized and phased array antenna systems divide the total power from a transmitter among various transmission azimuths and the power may be distributed equally or at varying levels among those azimuths. The radiated emissions are directionalized along each sector or azimuth in order to communicate with an associated receiver. Accordingly, these antenna systems may resemble point-to-point operation at any given moment. Therefore, we propose to allow such systems to operate at the same power levels as point-to-point directional antennas. Specifically, we propose to limit the total power that may be applied to each individual beam to the applicable power level specified in Section 15.247(b), i.e., 0.125 watt or 1 watt, depending upon the type of modulation used.<sup>1</sup> This implies that the total operating power, the aggregate power in all beams, could exceed the output power permitted for a single point-to-point system. We propose, therefore, to limit the aggregate power transmitted simultaneously on all beams to 8 dB above the limit for an individual beam. For instance, the 8 dB limit will enable antenna systems to create up to 6 individual beams or sectors, all operating at the point-to-point limit. Such an implementation is based on our understanding of the capabilities of existing technology. Finally, we propose to require that the transmitter output power be reduced by 1 dB for each 3 dB that the directional antenna gain of the complete system exceeds 6 dBi. This requirement is similar to the present rules for point-to-*

*point operation in the 2.4 GHz band. We seek comment on these proposals. Further, we seek comment with regard to whether the Commission should specify a maximum E.I.R.P. limit for each individual beam. If so, what should that limit be?*

YDI Reply to Para 12:

YDI agrees that sector antennas at base stations operating on a single channel used in point to multipoint (P-MP) be allowed the same Effective Isotropic Radiated Power (EIRP) rules as point-to-point (P-P) systems. For example a directional sector antenna with 14 dBi gain should be allowed to have a transmit power of:

$$30 \text{ dBm} - (14 \text{ dBi} - 6 \text{ dBi})/3 = 27.3 \text{ dBm} \quad (\text{"3 for 1" power reduction rule})$$

and an EIRP of :

$$27.3 \text{ dBm} + 14 \text{ dBi} = 41.3 \text{ dBm}$$

While this EIRP may seem high, in order to get the desired gain, any given sector antenna must severely narrow its vertical beamwidth. When properly deployed by a trained “professional installer”, it should have the correct down-tilt and have a very focused coverage area. This help mitigates interference to other systems in the area.

The primary benefit of this higher EIRP would now be a balanced two-way transmission system from base to remote and vice versa since the EIRP of the base sector antenna will now match the EIRP authorized by the remotes, which are considered point-to-point links when talking back to the base. This will allow for maximum performance, especially in rural areas where these systems are most needed.

So the question posed to the Commission is: if an antenna narrows the horizontal and vertical beamwidth, what difference would it make if the link were used P-P or P-MP? They both will carry traffic over the air. So why restrict EIRP on a sector antenna at a P-MP base? YDI sees no reason to do that and supports the notion of higher EIRP at a base sector antenna for P-MP operation. But we do suggest that for the purposes of rules making, a sector antenna be defined as one that has 180 degrees or less horizontal beamwidth.

16. *Section 15.203 requires that intentional radiators be designed such that no antenna other than that supplied can be used with the device. The rules state that the device can be designed such that a broken antenna can be replaced by the user; however, the use of a standard antenna jack or electrical connector is prohibited. These rules are intended to prevent intentional circumvention of the Part 15 emission limits by replacing a device's authorized antenna with an antenna having higher gain characteristics.*

## YDI Reply to Para 16

It is our understanding that the OET has already authorized use of standard antenna jacks on Part 15 devices, without mandating professional installation. So we are unclear as to the change proposed by this ruling. But YDI does support using standard connectors provided that these systems are professionally installed.

17. *We wish to develop more flexible antenna requirements for unlicensed devices. We propose to provide that flexibility by requiring testing only with the highest gain antenna of each type that would be used with the transmitter at the maximum output power of that transmitter. Any antenna of a similar type that does not exceed the antenna gain of tested antennas may be used without retesting. Use of an antenna of a different type than the tested antenna (i.e. yagi antenna vs. a horn antenna) or one that exceeds the gain of a tested antenna would require retesting and new approval by either a Telecommunication Certification Body or the Commission. Manufacturers would be expected to supply a list of acceptable antenna types with applications for equipment authorization.*

## YDI Reply to Para 17

It is our understanding that this rule is essentially already in place. Part 15 devices are only tested with the highest gain of each type of antenna. YDI supports this and already lists the acceptable antennas for its certified systems.

18. *Wireless Internet service providers (WISPs) have expressed a desire for more flexibility in the Part 15 equipment authorization rules so that they can mix and match the components of a radio transmission system without the need to obtain an equipment authorization for every combination. The rules generally require equipment authorization for a complete device, including the radio transmitter and a specific antenna. Further, Section 15.205 prohibits marketing of external radio frequency amplifiers, except as part of a complete transmission system consisting of an intentional radiator, external radio frequency amplifier and antenna.<sup>2</sup> The system may only be used in the configuration that was authorized. WISPs assert that they often experience difficulty in tailoring their radio transmission systems to meet particular needs due to the lack of flexibility in equipment authorization. For example, WISPs may be unable to change antennas to suit a particular application, even though such a change does not alter the operating parameters of the system. They assert that increased flexibility would foster competition in the supply of equipment and allow for greater innovation in the design of systems appropriate to the particular engineering challenges each WISP faces.*

## YDI Reply to Para 18

YDI disagrees with the notion put forth by some WISP operators that there is a paucity of FCC certified systems available to meet their various needs. This is simply not the case. There are many certified options available for just about any need a WISP may have. Equipment manufacturers and system providers, such as YDI, analyze the need of the WISP industry and apply the latest radio technologies to offer excellent solutions to

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WISP operators. The result is that there are many certified systems readily available for deployment. One just needs to attend trade shows such as the WCA Symposium, WISPCON (sponsored by Part-15.ORG) or the Broadband Wireless shows to see just some of these existing systems. A review of industry magazines such as Broadband Wireless Business also shows a plethora of system available and that new and competitive systems appear regularly. There is no practical reason why a WISP needs to buy components (radios, amplifiers and antennas) from different vendors and throw systems together like Amateur Radio operators. Nonetheless, YDI sees a lot of this going on in the field and the results are uncertified system whose transmitter power and spectrum emissions are not at all compliant with the FCC rules. YDI feels that this behavior should be *discouraged*, not encouraged or, worse yet, made legal.

It has been our experience that most ISPs who wish to become wireless operators know little or nothing about RF technology. For example, a noteworthy self-appointed spokesperson for this industry publicly admitted that he was unaware that amplifiers had gain. He just thought that amplifiers only had power. This same spokesperson also published pictures on the Internet of his installations that are clearly *not* FCC certified systems. To allow these types of inexperienced operators to piece systems together without any testing in labs will almost certainly result in emissions that would not pass the FCC emissions mask.

If the Commission allows this type of behavior to occur, it will be contrary to their wishes of minimizing harmful interference to both other unlicensed systems as well as licensed and restricted bands not only adjacent to the licensee-free bands, but to the harmonics of these bands that fall into restricted bands. Ironically, if the Commission allows systems be thrown together haphazardly, the resulting noise that will likely be generated will hurt not only the operators themselves but other WISPs in the area. One only has to see the spectrum of a DSSS getting compressed in and external amplifier to see the potential for interference.

YDI has a lot of first-hand experience in this. Many of our customers deployed “home made” systems only to have intolerable self-interference that resulted in their systems not working. This was generally caused by amplifiers that were not designed or tested with the radios the operator was using, emitting very strong sideband noise. When they replaced their system with a certified YDI solution, they achieved successful results because our system had been properly tested.

In an attempt to explain how amplifiers work in a system, YDI has an on-line presentation available on the Internet:

[www.ydi.com/amp2440](http://www.ydi.com/amp2440)

We also have a White Paper written on the subject:

[www.ydi.com/deployinfo/wp-using-amps.php](http://www.ydi.com/deployinfo/wp-using-amps.php)

The FCC is ever vigilant in ensuring that radio systems do not cause interference. Yet allowing this rule will have a long-term detrimental effect, the *opposite* of what the Commission desires.

*19. We are proposing a number of rule changes to enable WISPs to customize their transmission systems without the need to obtain a new equipment authorization for every combination of components. Specifically, we will allow professional radio system installers and parties that offer a commercial radio service under the unlicensed rules to substitute technically equivalent components in systems that have been granted equipment authorization. We believe such parties have the technical competence to ensure that the systems they deploy continue to comply with the FCC rules. We invite comment as to whether specific criteria are necessary to qualify as a professional radio system installer or commercial service provider, and if so, what those criteria should be. We also request views as to whether any other parties should be afforded similar flexibility. We will require the professional installer or commercial service provider to place a label on the transmission system that lists the FCC Identification Number of the system that was granted equipment authorization, identifies any components that were substituted, and designates a point of contact for the party that installed the system.*

#### YDI Reply to Para 19

We do not think that it is prudent to allow WISPs or any other operators to customize their transmission systems in the field. The main issue about the radio or amplifier swap-out is the ability of someone in the field to determine if another amplifier/radio combination is "technically equivalent". One of the key factors in this issue is the fact that DSSS (and more so even OFDM) requires that power amplifiers have linear amplification. If they are put into compression, the result is a significant increase in the sideband noise and harmonic content. To see this visually, one can refer to the spectrum plots found on this web page:

<http://www.ydi.com/deployinfo/rf-plots.php>

So the questions that someone in the field needs to ask are:

If it is a bi-directional amp, does that satisfy the "technically equivalent" requirement?

Does it have the same rated maximum transmit power?

Does it have the same transmit power gain?

The same 1 dB compression point as the certified amp?

The same (or better) harmonic content output for that particular radio and coax cable loss?

The same (or better) sideband noise output than when it is used with a certified radio and

coax cable loss?

What will the sidebands look like, especially near the band edges?

Will the out of band emissions of a 2.4 GHz amplified system comply with FCC emission limits, especially in the restricted bands at 2.4835 and 7.2 GHz?

There is no way **anyone** - not even an experienced RF engineer with suitable test equipment - can be confident in the field that another amplifier or radio is "technically equivalent" and that this modified system will meet Part 15 emission requirements. To think that all a radio operator simply needs to do is to pick a different amplifier and just "make a list" to be complaint is very scary. An operator can never know that he is polluting the spectrum if he has the freedom to put in any amplifier in they want. In fact, this proposed rule will permit an operator to start with a certified system and simply swap out each item one at time until they have a different radio, amplifier and antenna, make a "list" of what they changed and be compliant with the rules. When done on a wholesale basis across the country, the net result will raise the noise floor, strong emissions in the adjacent and harmonically related licensed and restricted bands, not to mention interfere with other 2.4 GHz uses.

If this ruling passes as written, the Commission will give virtually any users the license and authority to use whatever equipment they want with impunity simply based on their "opinion". All they need to do is "make a list" with whatever changes they make. We cannot imagine that the Commission really thinks that this is a good idea. It is our opinion that in the long run there will be more interference and the net result will be a polluted band that will hurt all operators.

Comment on "Professional Installer" (Para 19)

There is much confusion in the licensee-free wireless industry as to what constitutes a "professional installer". Legally speaking, any one who is paid to perform installation services can be considered a "professional installer". This, of course, does not make them competent. We propose that a certain minimum set of knowledge should be demonstrated by anyone to be considered a "professional installer". YDI frequently offers very inexpensive training in this technology and after giving many of these training sessions, we have a good grasp of the specific knowledge needed in order to be successful. More information on the YDI Training can be found here:

<http://www.ydi.com/support/training.php>

Perhaps the Commission can approve a syllabus and the knowledge be demonstrated via some form of a written test, not unlike the way Radiotelephone licenses are issued. Or as a middle ground, the Commission could authorize organizations (such as the WCA and Part-15.ORG) and even qualified manufactures to offer training sessions and conduct testing. A suggested Training Syllabus can be found in Appendix A of this document for

the Commission's review. YDI will be more than willing to assist the Commission or these organizations to meet these goals. In fact, YDI will be offering formal technical training at the Part-15.ORG's WISP Boot Camp in February 2004. For more information, visit:

<http://www.part-15.org/train/bootcamps.html>

YDI is also quite willing to meet with, train and brief the Commission staff if desired on the technical issues related to using the licensee-free bands for Internet access.

20. *We also propose to allow marketing of separate radio frequency power amplifiers on a limited basis. We will restrict such marketing to amplifiers that are only capable of operation under the spread spectrum rules in Section 15.247 and under the U-NII rules for the 5750 – 5850 MHz band. These are the rules under which WISPs currently offer most service and under which most unlicensed wireless broadband devices operate. Further, we propose to require that such amplifiers obtain an equipment authorization (certification) and demonstrate that they cannot operate with an output power of more than 1 Watt, which is the maximum permitted under the rules. We believe that this rule change would be of benefit not only for WISPs, but also for consumers and businesses generally. For example, consumers and businesses would have the ability to obtain a separate amplifier if they find the device they have purchased has insufficient operating range to meet their needs. We invite comment as to whether we should instead provide only a more narrow relaxation to allow separate marketing of power amplifiers that are designed in a way such that they can only be used with a specific system that is covered by an equipment authorization, such as through use of a unique connector or via an electronic handshake with a host device. We also recognize that frequency hopping systems that employ fewer than 75 hops are limited to an output power of 125 mW and invite comment as to whether the unique connector requirement may be necessary to ensure that 1 Watt amplifiers are not used with devices that are limited to 125 mW. We invite comment on these proposals and solicit views on other ways the equipment authorization rules might be modified to provide added flexibility without creating undue risk of interference to radio services or unlicensed devices.*

#### YDI Reply to Para 20

YDI supports the marketing of separate radio power amplifiers ***provided that*** the operator or installer deploys them as a certified system. Either the amplifier or radio manufacturer should provide this deployment information. Further, amplifiers cannot be certified as stand alone devices since their output is whole dependent on the transmit spectrum and power that comes out of the radio. The reasons we are taking this position are outlined in our response to para 18 and 19.

21. *The current rules permit digitally modulated systems to operate in the 5.7 GHz band under either the Part 15 U-NII rules or the Section 15.247 spread spectrum rules. Under either set of rules, the devices are limited to a maximum output power of 1 watt. However, the method used to determine the maximum power varies for U-NII use and spread spectrum use. Specifically, the output power measurement made in accordance with the Commission's U-NII device test procedure is an average measurement, while the output power measurement made in accordance with the*

*Commission's digitally-modulated spread spectrum device test procedure is a measurement of the overall peak emission. In adopting the U-NII rules, the Commission recognized that digital modulation techniques often display short duration peaks that do not cause increased interference to other operations. Measuring the peak level of short duration spikes overestimates interference potential. Accordingly, the Commission established measurement procedures for digital U-NII devices which allow for averaging output power in order to disregard these insignificant spikes.*

## YDI Reply to Para 21

The comment that “*digital modulation techniques often display short duration peaks that do not cause increased interference to other operations*” may be true with other radio systems, but it is simply not the case with the type of systems used for wide-band data transmission on the licensee-free bands. In practice, the pulses are oftentimes not short, and even if they are they will cause interference and lost packets if the signal strength of the pulse is strong.

In Time Division Duplex (TDD) systems especially (which comprise the vast majority of radios deployed) a data packet received by radio A could be destroyed by a brief but strong signal transmitted from an interfering radio B. Even if said interfering signal from radio B is just a fraction of the duration of the received data packet on radio A, the whole received packet will be discarded and re-transmission will be required. The effect is to slow the effective throughput of the system down. The more packets that get destroyed, the worse the data throughput slows down. So the perception that these short durations spikes are harmless is simply not true, regardless of the method of modulation used by either radio. The only consideration on whether a received packet is destroyed is the relative level of the two signals. For example, if the received signal is DSSS, it will have processing gain protection. If it is a wide-band FM signal, it will have a good C/I ratio due to the capture effect of FM. But regardless of the modulation technique used, at some point a short interfering signal will be strong enough to destroy a received packet, regardless of the duration of the interfering transmit signal.

The second misconception is that many of these packets are “insignificant spikes” and that since the pulses of data are so short, the transmit power should be measured as an average, not at peak. This assertion does not take transmit duty cycles into account. Most times, like when an Access Point (AP) is beaconing, the duty cycle is very small. For 802.11b, for example, a 250-microsecond pulse is sent out every 100 milliseconds. However, when sending data during a download to a client device, the transmit duty cycle of an AP may approach 90%. Time and again, we work with operators who have not deployed a WIPOP (**W**ireless **I**nternet **P**oint **o**f **P**resence) base station properly yet have good results when the system is initially deployed. However, when they start loading up customers and the transmit duty cycle on the WIPOP with multiple base transmitters goes up, local interference at the base causes the received packets from the remote clients to be lost.

So while we are not necessarily suggesting that the Commission always measure peak output power, we are suggesting that the Commission take both the duty cycle and interference potential into account when determining transmit output power regulations.

23. *Accordingly, we propose to harmonize the measurement procedures for digital modulation devices authorized under Section 15.247 with the digital U-NII devices authorized under Section 15.407. Specifically, we propose to allow entities performing compliance testing for Section 15.247 devices to use an average, rather than overall peak, emission as provided by Section 15.407, paragraphs (a)(4) and (a)(5) when measuring transmit power. We propose this change for devices using digital modulation that operate in the 915 MHz, 2.4 GHz and 5.7 GHz bands. We seek comment on whether a change in measurement procedure for such devices would have any detrimental impact on the installed base of products.*

YDI Reply to Para 23.

We agree with the proposal to harmonize the measurement procedures for Part 15.407 and 15.247. However, the Commission needs to take the maximum transmit duty cycle into account least there be massive interference at P-MP base stations with multiple independent TDD channels operating.

24. *Aside from the differences in measurement procedures, Section 15.247 and U-NII devices also differ in spectrum occupancy characteristics. For example, a Section 15.247 device operating in the 5.7 GHz band is required to limit peak power spectral density to 8 dBm in any 3 kHz band, which equates to 33 dBm in any 1 MHz band. Unwanted emissions from such a device are not required to be attenuated to the general emission limits of Section 15.209. Conversely, the same device, if authorized pursuant to the U-NII rules, would be required to limit its power spectral density to 17 dBm in any 1 MHz band and to limit unwanted emissions to the levels specified in Section 15.209. Realizing that a device may occupy the same spectrum band differently depending upon the rule section under which it is authorized, would a common procedure for measuring output power be appropriate and provide an accurate assessment of device performance? Should we amend the spectrum occupancy rules for Section 15.247 and U-NII devices to apply the same limits to both types of devices, and if so, which limits should be applied?*

YDI Reply to Para 24

We agree with the proposal to harmonize the measurement procedures for Part 15.407 and 15.247. We suggest that the higher limit be used if the intent of the Commission is to enable these bands to get the maximum performance needed for outdoor systems.

### **Specific requests:**

1. YDI requests the EIRP rules (i.e., the “3 for 1” transmit power reduction rule) that apply to point to multipoint (P-MP) systems be the same as those for point-to-point links when using sector antenna with a horizontal beamwidth of 180 degrees or less.
2. If the FCC wishes to liberalize the use of external amplifiers, YDI suggests that it be put in the hands of the manufacturer, not the installer or operator in the field. YDI proposes that once an amplifier or radio manufacturer has an amplified system FCC certified, they be allowed to make variations in their Certified Systems via Class I Permissive Changes to include different radios and different versions of amplifiers. In other words, put the burden of compliance to the emission rules on the amplifier manufacturer who has the means to determine if an equipment substitution is “technically equivalent”, not on the field installer.
3. YDI requests that the proposed rule 15.204 (b) (ii) not be adopted for all the reasons stated in this document.
4. There is a lot more to spread spectrum amplifiers than just output power. Its maximum output power is just one of its technical parameters. YDI requests that the proposed rule 15.204 (b) (iii) be re-written as follows:
  - a. An external radio frequency power amplifier may be marketed for individual sale provided it is used in conjunction with an authorized system.
5. YDI supports that unlicensed systems with standard connectors require professional installation. We request that the Commission provide a clarification or definition of a “professional installer” if they intend to use the term in the rules. We suggest that a minimum standard be applied in order to qualify someone as a professional installer. Consideration should be given to requiring some sort of training and/or passing a test.
6. YDI requests that the Commission re-evaluate the need for keeping the following bands as restricted bands:
  - 2483.5 to 2500 MHz
  - 2310 to 2390 MHz.

Are these bands being used in the U.S. such that they need that extra protection? If 2483.5 to 2500 MHz were no longer restricted, operators in the U.S. would be able to operate on 802.11 channels 12, 13 (and possibly 14) like Canada and the rest of the world does. Likewise, some 2.4 GHz amplified system (now restricted on the upper or lower channels) will be able to operate on the lower and upper channels which they cannot operate on now due to transmitter sideband noise from the DSSS signal.

The question that YDI is putting to the Commission is: Does keeping these bands restricted truly support the primary FCC mandate of serving the public's interest, convenience and necessity? Or does removing the restriction on some or both of these bands support better use of the unlicensed frequencies?

## **Appendix A**

### **Proposed Training Syllabus for Professional Installer**

Drafted by : *Michael F. Young, YDI Wireless*

#### **Topic 1: Regulatory and Standards**

- License Free Radio Bands (900 Mhz, 2.4 GHz, 5 GHz, 24 GHz and 60 GHz)
- FCC Part 15 Rules relevant to Intentional Radiators
- Relevant IEEE 802.1 standards (801.11a,b,g, 802.16a)
- Overview of Part 15 Certification process and requirements

#### **Topic 2: Radio Basics**

- Understanding technical terms used in radios (dB, dBm dBi, EIRP, etc)
- Types of radios (HDX vs. FDX)
- Coax cables characteristics (types, loss, applications)
- Coax connectors commonly used
- Basic Wireless Internet Systems on 2.4 GHz and 5.8 GHz WIPOP Systems

#### **Topic 3: Types of Modulation and Their Characteristics**

- FHSS, DSSS, OFDM radios and characteristics
- Processing Gain
- Non-spread spectrum radios (Wideband FM, PSK, QPSK)
- Occupied spectrum for all of the above, including understanding spectrum plots for various radios

#### **Topic 4: Antennas**

- Antenna Basics
- How antennas work
- Basic antenna characteristics and important features
- How to read and understand antenna spec sheets and plots
- How to use antennas for specific applications

#### **Topic 5: RF Propagation**

- Free Space Loss
- System Operating Margins
- Fresnel Zone issues
- Down-tilt antennas: how they work, what they do; calculating coverage areas

#### **Topic 6: Amplifiers, Converters and Signals**

- How amplifiers work; what they do and don't do
- When you should and should not use them
- FCC issues when using amps
- 2.4 to 5.8 GHz Up/Down Converters
- Signal, Noise, and SNR Analysis and how to troubleshoot with it.
- Amplifier installation tips and Do's and Don't's

**Topic 7: WIPOP Base Stations and CPE options**

- Understanding sample Systems
- Base Station Antenna installation issues
- CPE options
- Practical tips for setting up a WIPOP Base Station

**Topic 8: Millimeter Wave Bands (24 GHz and 60 GHz)**

- Characteristics of these radio bands
- Benefits and hindrances
- Usage in real-life application

**Topic 9: System Issues**

- Security and Authentication Methods and Ideas
- WEP and WEP-Plus encryptions
- Interference issues and possible solutions

**Topic 10: Installation Issues**

- Waterproofing connectors
- Strain relief and cable support
- Grounding Issues
- Lightning Protection options and considerations
- Coax cable issues at 5 GHz and higher
- CPE installation considerations
- Proper antenna installation, esp. down-tilt angles for sector antennas
- Safety issues

**Topic 11: Bandwidth Management for P-MP Wireless Internet Systems**

- Why it is needed
- How do they work
- Practical applications and deployment